# ON THE ORIGIN OF STRUCTURES IN PLANTS

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THE systems of organs of which a higher plant more especially is composed generally hold an intimate physical relation to one another. They are bound together so intimately by reason of their position in root or shoot that the growth, development or response to stimulus of one is in a very great measure molded by the growth, development or reaction of all the rest. In addition to these considerations, when the origin of tissues or of organs is being investigated, account must also be taken of the nutrition of the special organ as well as its especial relation to environment external to the plant of which it is an integral part. Thus the complex physical interrelations, and the physiological correlations as well, make the study of the functions, and behavior of the individual tissue, or organ, as a possible independent unit one of great difficulty. These general facts probably hold for plant tissues as a whole, but one system, namely, the trichomal system, offers a favorable field in which to study the origin, development and biological relationships of plant organs, inasmuch as it is comparatively little affected by other tissue systems. Beyond growing out of epidermal cells, remaining permanently attached to the epidermis, and deriving nourishment from the subjacent cells, the trichomes lead an independent existence, and in origin, development and form are not directly influenced, as the other tissues are affected, by the pressure of enveloping tissues, and in certain plants, as *Franseria dumosa,* the trichomes go one step further on the road to independence, in that they are chlorophyll-bearing and in a sense probably auto-trophic. For these and other

reasons the trichomes are favorable for the study of the origin of plant structures, as I recently found while working on certain hybrids, a detailed account of the results of which will be given in another place.

The walnuts, to which reference is made, bear 4 or 5 types of multicellular hairs, besides certain abnormal and one aberrant type. These are composed of 6, or 8 cells, or about 16 or about 32 cells. A close study of the development of the trichomes, in which mitotic figures were used as indicators of the course of cell division, showed the following to be facts: (1) In the earliest stages of development of all of the normal trichomes, the sequence of the first two, or three cell divisions was the same; (2), the sequence of cell divisions of the 6-celled and the 8-celled trichomes, during the entire development, is consistent; (3), the 8-celled trichome recapitulates faithfully the sequence of cell divisions of the 6-celled type up to the six-celled stage, and then adds two divisions in an order not departed from. Certain facts indicated that the late cell divisions of the two larger forms of trichomes, namely, those with about 16 and about 32 cells, do not hold to a sequence so closely, but further study of these difficult trichomes might modify this conclusion. These facts indicate that all of the multicellular trichomes may have originated in a common ancestral form and that by

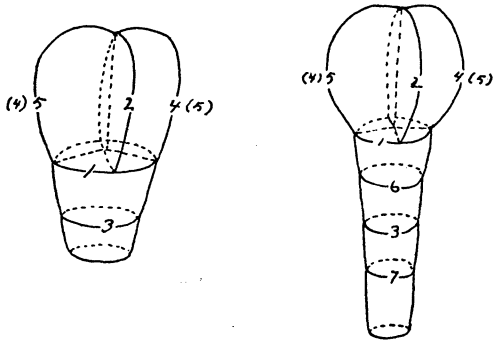


FIG. 1. Semi-diagrammatic sketches of 6- and 8-celled trichomes to show the Cell Lineage of each. The numbers refer to the sequence of the formation of the cell walls.

arrested development, or other differentiation, the various types of trichomes now to be found in Juglan's species have arisen. Certain of the trichomes are evidently more closely related to one another than to other types, and thus the trichomes are not all of equal age, but have been derived from an ancestral form at various times in the history of the plants which bear them. It is very probable, for instance, that the 6-celled type is more nearly related to the 8-celled type of trichome, than it is to either of the larger forms, but it would be difficult to say which represents the more ancient type. In development, and probably in origin, the types of trichomes thus behave as if they were separate organisms, or independent units of a complex organism. This is not the same as saying that each type of trichome is a "unit character," although certain observations which I have made on the distribution of trichomes in another plant, as well as the reversion of the trichomes in the second generation of *Juglans californica* × *Juglans regia* would justify this conclusion. Should it be the experience of other observers also that each type of trichome has its peculiar area of distribution in a plant, the conclusion that each form of trichome represents a separate unit character could not be avoided, and from such structural studies as above reported we should be able to trace their very origin as separate portions of the tissue of the plant.

In addition to the normal types of hairs in walnuts, as given above, there are also other types. Of such, there are certain abnormal forms which are evidently related to the already existing trichomes, of which they are slight modifications, and one aberrant type which is essentially different from these. The origin of the aberrant form was seen also, and was found to be as different from the mode of origin of the normal trichomes as the mature aberrant type is different from the mature normal form. In brief, its departure from the normal takes inception in the orientation of the first cell wall, which is longitudinal in place of being transverse as is usually the case (Fig.

2). Consequently it happens from this single initial deviation, there arises a form of trichome, unrelated to other existing types, and, consequently, of which it can in no wise be said to be a modification. In fact the new hair is a mutation, and its history shows in at least one way how such variation has its origin. In this instance there is no disappearance of intermediate forms of trichomes, since for structural reasons there can not be such.

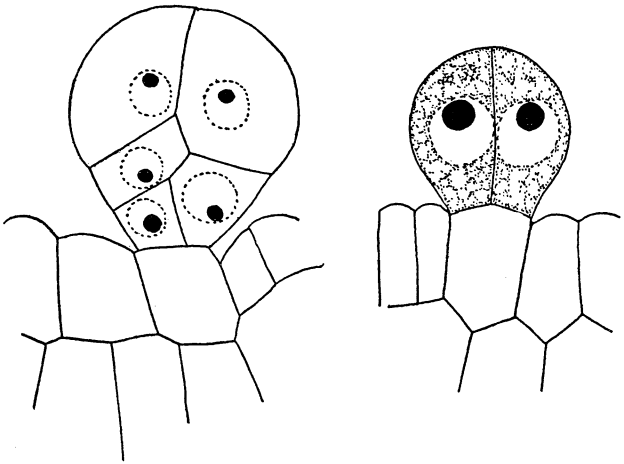

FIG. 2. Mature aberrant Trichome and two-celled aberrant Trichome, in which the first cell wall is laid down parallel to the long axis of the mature hair.

We therefore find in Juglans that the different types of multicellular trichomes may take their origin in one of two ways, namely, they may arise as modifications of types already existing in the plant, which is apparently the usual manner, or they may arise suddenly and hence provide points of departure for subsequent trichome formation and differentiation of which they would be the ancestral type.

The physiological reasons for the differentiation of the trichomes were not investigated, but observations indicate a close relation between size of hair and the position occupied by it on the plant member, and suggest that the factor of nutrition may be important in inducing certain, at least, of the irregularities noted.